

Digitalization of Interior Material Library to Enhance Teaching-Learning Process

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Abstract. The concept of the library is evolving from the conventional storage for books into a digital information centre, a place to dive deep into sources of knowledge. The urgency of digitization has led by the requirement of distance learning, the flexibility of accessing resources and building a preserved collection in digital form. Interior Design Department BINUS University realizes the need for digitization could help students and lecturers to cope with the situation. In this research, a study case in the interior material library of BINUS University is conducted to show step by step process of digitizing the material library collection. The approach holds three significant steps; the nomenclature study by making categories and coding the samples, transferring material samples into digital formation, and preparing the digital platform to broaden the users' access. The result of this research is elaborated, and lessons learned from the process. The review can develop further research in the digitization of the interior material library in the future.

1 Brief History of Library

Since the first Library of Ashurbanipal in Nineveh, Capital of Assyria has been discovered by Sumerian in 3.000 BC [1], the concept of library had developed in countless number. Date back in millennia, Babylonian people in Mesopotamia had created the concept of library as source of knowledge written over the cuneiform tablets. Science, religious practice, norms, and other discovery resources on the era of Babylonia was stored on the tablets to preserve their valuable knowledge. Noble archiving system was also played important role for the Babylonian knowledge to be spread over in the era [2]. For years, the concept of library then changing more than just storing resources but also as the source of knowledge. Library has been developed throughout the evolution, from the ancient Alexandria (open access palace library) into the modern library we recognize today. The evolution alone was exposed by the need of expanding empire [3], self-educating [4], discussion, a place to find resources, meet colleagues, study, and even for recreational purposes. The purposes of library service will always be evolving along with the function demanded by the users. Inarguably, new demands on the technology-related services and wide range of access to the information available in the library are prompting libraries to enlarge its services [5]. Because of this function, library is possible to be defined beyond solely as a place. It can act as a concept to connect people to the information and/or connect people to the knowledge in broader context.

To date, where digital technology has drastically changed the way people create and use information [6],

quantity and variety of digital collections in the library are growing. It obtained from the advance development of computer technology and network in post-industrial era. Likewise, the awareness of today's generation to preserve artefacts or physical data from damage and prevent the excessive use of paper are encouraging the movement of digitization of the library collection in many institutions. It was not far from the beginning of Covid-19 outbreak, which was first announced in early 2020, that has brought many aspects of acceleration in digitization. Digital form, especially for libraries, can be the best alternative for information, data, and reference gathering while working and learning from home are mandatory. In a wider sense, information can be digitized from a variety of media, not only through hardcopy books, or journals, but also from the physical material samples and mock up. Through digitization, a program can be developed by library to allow registered users to access the library's data and collections, regardless the location issue [7].

The Interior Design Departments of Bina Nusantara (BINUS) University has a material library as one of the teaching-learning facilities. Located in Syahdan Campus, the material library located in a limited space, which presently filled with catalogues and material samples for interior finishes. Such samples of floor finishes; ceramic, carpet, tiles, wood parquet, vinyl flooring, wall finishes; wallpaper and wall paints, ceiling, and furniture finishes; high pressure laminate, fabrics and so on (Figure 1). These catalogue collections and material samples came from various brands and were obtained from the company partners and alumni. In this material library, students can explore various interior materials that can be used in their

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interior design projects to make material concepts as well as analysing various type of materials that are suitable for their projects. During the pandemic, people were asked to stay at home, reduced their mobility, and access to public places, including campuses and other learning facilities. This situation caused the reduction of the students' learning activities, especially to study the physical objects. To encourage sustainable learning for the students, one of the solutions to this problem is through a digital material bank or digital material library, which can be accessed online by multi-campus students anywhere and anytime. Thus, the learning process and material exploration can continue even though access to the physical material laboratory is limited.



Fig. 1. Material Library, Syahdan Campus

Moreover, interior materials are products that will always continue to develop and evolve, whether following the latest trend, or innovation. Thus, when new physical samples arrived, the old ones will still be kept, which causes accumulation and collection pilling up. Therefore, having digital material library will be very beneficial since it can store enormous amount of digital data and very easily accessed by anyone from anywhere, as long as they are connected to the internet [8]. With a digital material library, the physical collection can be sorted to the latest and certain important samples only, while the rest of the older collection can be stored digitally. Despite its benefit, the process of interior material digitization in academic context has never been documented before. The aim of the study is to review the interior material digitalization process with Binus University's interior material library as a study case. The material samples available in the material library are focused for study purposes.

2 Method

To achieve the aim of this study, which is to review the interior material digitalization process in the interior material library of BINUS university, qualitative method with grounded theory approach was conducted. This approach considered as a general method to develop a theory based on data collection and data analysis [9]. It is also used because of its systematically order procedure. The questions in grounded study will focus on the understanding of process and the steps in the process.

Based on the determined approach, data collection was done qualitatively by collecting secondary data or literature review. In this stage, all relevant data from various sources were gathered through classification system. The classification system will become the standardized classification system in the physical library as well as the digital library and as a result, the users can easily find the collection they are looking for. The literature review was analysed the detail and the challenges found within the digitization process. The next stage of this study was the digitization process itself as the primary data collection stage. Using the materials available in the physical material library, the steps of the digitization process broke down into classifications and coding process, digitization process by transforming the physical material sample into digital form, these steps can be done through taking photos, videos and other techniques that are commonly used to archive visual data. Afterwards, the supporting data collection process, such as characteristics, ingredients, dimension, standard quality of the materials and so on was done. Lastly, the process of archiving and uploading digital data to the digital platform was conducted. The results from the digitization process were reviewed and analysed to develop a schematic diagram of digitalization process, as well as to find out the challenges, pros, and cons of digitization process through descriptive analysis method.

3 Experiment and Result

Even though the study is still limited, digital material library is not something new, there are examples of digital material libraries that are available and accessible to the public, for example the Institute of Making, a digital material library belongs to UCL Civil Engineering and Materials Workshop which belongs to an academic institution, A Plastic Planet; a digital material library which profiles alternatives materials and Design and Architecture Scotland's A Library of Sustainable Building Materials which belongs to industries or material companies. These digital libraries offer different features, such as detailed 2D images and 3D images with 360 degrees rotation videos. These images are also completed with descriptions and specifications of the materials, some even provide a list of suppliers and distributor companies.

As of now, the study of digital library that is specifically applied to interior materials are still limited. Therefore, as background to the study purposes, the discussion of digital libraries in general will be used. Witten, et. al mentioned three distinct roles of digital library in education; first as a learning platform (students experience), second as an authoring space (also in support of student experience) and lastly as a teaching resource (course development) [10]. An early definition of digital library according to Lesk, is organized collections of digital information. They combine the structure and gathering of information, which libraries and archives have always done, with the digital representation that computers have made possible. Another more complex definition of digital library by Digital Library Federation (DLF) in the United States agreed on definition of digital

library: Digital libraries are organizations that provide the resources, including the specialized staff, to select, structure, offer intellectual access to interpret, distribute, preserve the integrity of, and ensure the persistence over time of collections of digital works so that they are readily and economically available for use by a defined community or set of communities (DLF, April 21. 1999) [8]. Thus, we can conclude that digital library is a collection of digital information that are structured and preserved, the collection itself is not limited to digital books or other written materials but can also include digital information from collection of things; from museum, galleries, and in the case of this study is collection of interior materials samples and finishes.

Digitization is a terminology that is increasingly used in the past years, it is a term to describe the process of transferring media from printed, audio or even physical form to digital form with the purpose to meet users' needs and to improve performance [11]. In the past twenty years, academic libraries across the world digitized by their respective organizations with the use of computer technology known as "automation or digitalization or digitization". Digitalization of academic libraries have proven boon for both, the library professionals and research community' across the world [12]. Digital formation of information served in the libraries will provide better than the conventional one [6]. It overlooks the classical barriers built by the physical presence, such as virtual or hybrid learning and fast pace working environment. Therefore, digitization in this era has been reviewed as a powerful method to provide and preserve sources of knowledge. As Arms pointed out, the flexibility in reaching data (digital library brings information to the users), facilitate the need of information sharing and keep current, and cost effectiveness are among the potential benefits offered by the digital libraries [6]. To do so, the digitization of library collection then also need to keep an eye of any standards in optimizing its service.

Creating a digital library certainly need a careful planning to meet the end users' requirement with the quality standard. Technical feasibility is one of the most important criteria for selecting material for digitalization [13]. The list does not stop there. The selection and source of material, the requirements and features of digital library collection also need to be determined, as well as the approach of digitalization are included in the parameter. For digital library, the conversion of physical or hardcopy materials into digital format is a crucial task. The equipment used need to be carefully selected; computer, scanner, digital camera, and software for editing need to be chosen according to the digitalization approach. More importantly if the objects for digitization are interior material samples which has their own specific characteristics, (colours and textures, 3d scanner or digital cameras with proper lighting) will be more suitable, unlike general library which the objects mostly are all written materials, in which 2D scanner should be sufficient. Furthermore, the format of the documents, the time length for the conversion, who will carry out the digitalization; in-house facility or external contractor and workflow should also be clearly identified [14].

Based on the previous literature review, before starting the digitalization process we need to identify the scope, purpose, and the user targeted. In the case of Binus University digital material library, the scope, purpose, and user targeted are identified as follows; the scope of the digitization is the collection of interior material library located in Syahdan Campus, consisted of material collection from various categories and material companies. Since not all material samples eligible for digitalization, we chose only the eligible materials from each category. The purpose of digitization itself is to open opportunities for students to learn and explore interior material as part of their learning process even though access to library is limited or even restricted. In the long term, the digital material library is created to open wider access to the archived materials along with the detailed info. It is necessary for the university to run hybrid learning process so the students are able to have material references that can be accessed anytime and anywhere. For the explained scope and purposes, the target users are clear, they are interior design students in Binus University multicampus, however the digital material library can also be used by students from other departments if they are registered as Binus University students.

The interior material samples available in the material library consisted of materials from different categories and brands with different shapes, textures, and sizes, depends on the supplier or industries who produced the materials. Since there is a complex variety of materials, before starting the digitization process, we need to group and categorize the materials, followed with coding process. Moreover, since some of the company has its own coding only applicable to their own brand, thus a more general classification and coding system need to be created. This system is not only used for the digitalization purposes but also for storage and repository purposes.

3.1 Categorization based on NTIS and DDC Classification system

Classification system was needed to ease the search of material samples, considering the variety of material samples will always increase from time to time. Hence, creating a compact and understandable coding (nomenclature) in material library is also important as guidance for the users to find certain collection. Some of them are widely used by any kind of libraries in Indonesia oftentimes. There are several classification systems widely used by the librarian. This research is adapting NTIS (National Technical Information Services) and DDC (Dewey Decimal Classification) to create classification system of the interior material library.

DDC is a system in which classifying collection into 10 categories. As a classification system, DDC has elements such as systematic, hierarchy, notation, relative index, guiding tables, and code for specific works. Meanwhile, NTIS is developed to simplify the DDC classification system. NTIS do not have guiding table and the notation is simpler than DDC. Instead, it is using a category (in line with the need of the collection notation). It makes NTIS can be used faster to find collection. Below is shown the example of DDS and NTIS notation on the library collection.

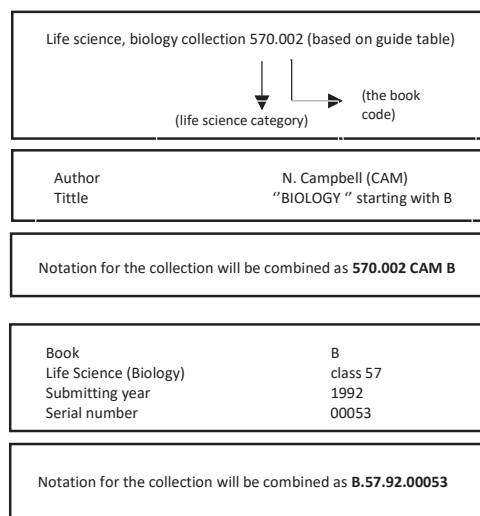


Fig. 2 Call number of the collection with DDC (above) and NTIS system diagram (below).

From figure 2 we can conclude that any kind of classification system need a category or class. This method will divide the collection into groups. In this study, we try to implement this system into the interior material sample collection. Samples on each group represents characteristic, techniques, ingredient, or application on interior design. Furthermore, the material samples should be coded refers to its groups/ category. The category will be followed by serial number and identified by the type of collection, and the name of the author/publisher.

Table 1. Material Category of Interior Material Library

No	Material Name/ Category	Material Code
1	Metal	M
2	Carpet Flooring	CF
3	Linoleum	LINO
4	Parquet and Panel Flooring	PQF
5	Vinyl Flooring	VF
6	Homogenous Tile	HT
7	Rubber Floor	RF
8	Curtain Fabric	CYR
9	Leather	LEA
10	Upholstery Fabric	UPHO
11	High Pressure Laminate	HPL
12	Plastic Laminate Sheet	PLS
13	Paint	PAINT
14	Coating and Finishing	CST
15	Non-Timber Forest Product	NTFP
16	New biomaterial	BIO
17	Natural fiber	NFIB
18	Ceramic/Porcelain/Potter	CT
19	Composite/Carbon Fiber/ Other	COM
20	Plastic based	PLAS
21	Glass	GL
22	Gypsum	GYP
23	Natural stone	NS
24	Paper	P
25	Solid surface	SS
26	Wallcovering	WLC
27	Wicker/Weaving	W
28	Students work	STU
29	Terrazzo	TER
30	Concrete	CONC
31	Shutters, Slide, Doors	SHUTD

32	Mosaic	MSC
33	Solid Wood	SW
34	Engineered/Processed Wood	PW

Based on the nomenclature study, we established certain coding system for the material samples available using the formula: [Material Code – Material Brand (shortened to 3-4 letters) – Series Code – Book No – Serial Number]. The coding system are created by combining the DDC and NTIS classification system, and can be used as follows:

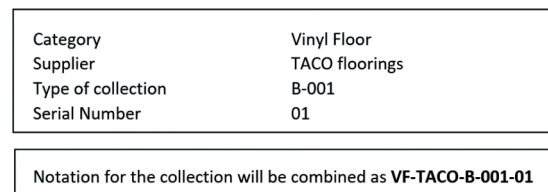


Fig. 3. Call number of the collection with adaptation of NTIS system.

For example, VF-TACO-B-001-01 will be read that the material is from vinyl flooring category produced by TACO, series B, catalogue book no. 1 and sample material no. 1 (Figure 3). This formula or call number is used for all materials available in the material library, thus every piece of material samples will have their own unique call number before the documentation process begin.

3.2 Documentation: Archiving image and provide data in digital formation

Before starting the documentation, we need to determine the aim of the documentation first. Is it conducted only for archiving purposes? Or is it a documentation activity to enhance the service of providing data for the interior design students' learning process? If the two of the questions are the main idea of this process, then not only flat images of material samples should be provided, but also information regarding the depth of the material surface, textures and colour tones should also be available. While in interior material library, the physical library offers a better experience for students, since there is a big difference between viewing an image of a synthetic rattan online and holding the real samples and ideally students need to touch and feel the texture of the materials to explore and understand them better. To achieve students' sustainable learning experience, this has become one of the main challenges of transforming interior material samples into digital form.

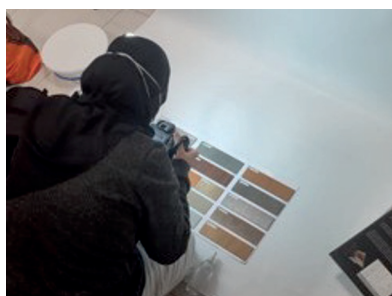


Fig. 4. Interior material documentation process

Altering process from physical sample to digital form is an important part of digitization of material library, considering the colour, saturation, texture, etc. There are two kinds of techniques used in this step; using a digital camera and a 2D scanner. Digital camera is used to take a picture with 3D surfaces such as weaving samples, stone, mosaic, and carpet. As shown on Figure 4, it will capture the depth and bumpy effect of the material so users can have the close relation to the real shape of the material. Also, lighting from the top view when the photo taken will illustrate glossiness and glare effect to help the textured materials to be shown in the digital form. The second one is by using 2D scanner. This technique is used to grab a flat surface such as laminate flooring and fabric. Advantage of using this type of documentation technique is the even lighting that will work best for the flat images, without any thickness, bumpy effect, and specific texture to be shown in the digital form. It will also show the proper images for materials with shell-like surfaces due to its sensitivity when contrasting the colour (Figure 5).



Fig. 5. Shells motif sample A (left), shells motif sample B (right)

There are number of aspects to be considered when transform material using digital camera and 2D scanner, included the right camera angles and proper lighting. Camera angles will help documentation image shown in various perspectives. It builds material dimension on the user' perception. Meanwhile, the right lighting effect will perform the best colour tone and help the user' grab the closest image of the material sample. It also will reduce the unwanted noise on the digital images. The details of strengths and weaknesses of both methods are listed in the table 2.

Table 2. Strengths and weaknesses using 2d flat scanner and digital camera.

	Recommended Materials	Strengths	Weaknesses
2D Flat Scanner	flat shell motif, checker	The lights are equally distributed among the surface	Requires editing to correct color

	motif, wallcovering material	of the materials, the shell or pearl like pattern can still be clearly seen, so does the glossiness. It allows detail, pattern, and texture appears equally.	quality close to the material's original color, the depth and shape of the material not clearly seen or felt, the glare is flat not following the shape of the real material.
Digital Camera	Carpet flooring, Upholstery Fabric, Weaving material	The feel of the texture, depth and softness of a carpet can be sensed better. It shows more depth and velvety texture that can be sensed, size of the texture, the bumps and glossiness can be seen more significantly. The 3-dimensional shapes and texture can be seen and sensed.	Textured materials require different lighting directions according to the character of the surface. Better light direction determines better dimensional effect.

3.3 Preparation for the digital material library platform

Since the main function of digitization was to open wider access to the users from anywhere and anytime, the presence of a digital platform for the material library collection is significant. The initiative of making the collection available virtually to be caught by the end users is coping the problem of collection piling up. It effectively will eliminate unbearable growing of the collections and solve the limited space for physical storage. Open access library will create a faster access and searching activities by multiple users at the same time which impossible to embark without appropriate Information and Computer Technology (ICT) facilities. From the analysis, one can infer the importance of creating a comprehensive digital platform linked through the internet access.

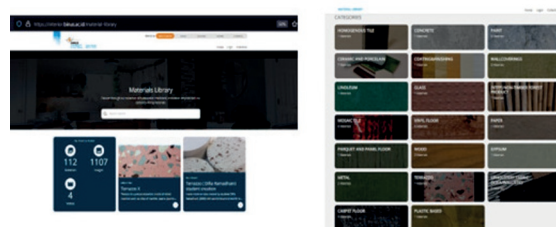


Fig. 6. Homepage and category view in material digital



Fig. 7. Sample of laminate surface from Kertasive

For the study case of interior design material library in BINUS University, a digital platform in website can suits this requirement, as it is easy to access via laptop, personal computer, or even smartphone and tablet. Students and lecturers can easily access the library whenever they need the information. While the distance learning or blended-model learning is conducted and physical material library visit are restricted, the digital platform can be functioned both as digital library and supporting materials for the related courses. As a digital library, student can access any information related to the teaching-learning process, while at the same time the material library collection can be accessed to fulfil the need of making mood board/material board in their Interior Design Class project presentation, or any other courses need more explanation about interior material. Therefore, a website has been launched and can be accessed through www.interior.binus.ac.id/material-library (Figure 6). Each sample on the physical library has its twin in digital form available on the website which has the same coding in the same category. On the study case, coding in the physical samples will be added to the collection prior to data input in the digital sample. Samples on the website also divided into categories based on the data in Table 1. Coding will be added to the material sample in metadata so the user can easily find the material using certain code. The digital image of the material samples will be completed with description of the suppliers/ producers/ brand to ease the identification of each material. In this study case, digital material library also partnered with authorized suppliers/ producer of the material to digitized and published digital form of materials. As seen in Figure 7, Also, metadata will be completed with information such as product description, dimension, durability, installing guide, videos and photos, and catalogue from the producer, if any.

4 Conclusion

In this digital age, information can be disseminated through varieties of media, not only through hardcopy books, journals or in this study, through physical interior materials. Following the rapid growth of information technology and the impact of the pandemic situation in the past years the technology transformation grows even faster. To achieve sustainable learning for interior students in exploring various interior materials, especially as impact of pandemic, a digital material bank or digital material library which can be accessed online by multi-campus students anywhere and anytime is developed. A careful planning of digitalization process is essential to meet the purpose of digitalization and user's

requirements, thus the scope, purposes, user target, requirements, methods, and so on need to be determined beforehand.

All the steps and process are done not without any difficulties, since it became a pilot project, this digital material library is facing challenges in defining standards for scanning and transferring images from the physical material samples to digital formation. It needs to consider the quality of lighting to capture the real image, produce immersive yet experiential material sample (providing similarity to the texture, dimension, and bumpy effect), color precision, and resolution at its best for mood board making purposes. In the future, the imaging standard is playing an important key role as it is representing the information that is needed by the students and help them relate the materials (characteristics, dimension, and colors) to their project requirements such as nuances and ambiance, conceptual mood, style, proportion on a space, and installation. The right image will create better understandings to the material samples. Physical and digital data synchronization is also a time-consuming process. Both digital collection of interior material library and its physical samples has the same coding simultaneously. When the data changed in digital library, metadata could help the librarians to maintain the data carefully. But the challenge occurs when the data from the physical sample has changed, it took time for the librarian to fix the coding one by one. In the process of coding and documenting, however, the most time-consuming process is to put coding to the physical samples, considering the quantity of the collection per item can exceed 3 pieces. It is required a system in the future to make coding process and synchronization between the physical samples and digital samples easier and faster.

Lack of knowledge in digital photography especially during the documentation process becomes the limitation of this study. Further studies about user experience and how well students use this digital material library need to be discussed to improve the function of the digital material library. With the growth of digital technology within interior architecture has opened an opportunity for further research. Not only to digitalize the material samples and establish an online repository, but also to study on how these material images can be applied directly in 2 or 3-dimensional drawing and modelling.

Acknowledgment

The authors are gratefully acknowledge Digital Media Development (DMD) Binus University for the support of developing the material library repository platform, and PT. Tri Kerta Interiondo (Kertasive and Monostar) for the support of material samples. The authors also acknowledge the present research is supported by Bina Nusantara University.

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